

National Aeronautics and Space Administration

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Wernher von Braun
Memorial Symposium
October 21, 2008



Ares I Integrated Test Approach



Ares Launch Vehicles



◆ Ares I Crew Launch Vehicle

- Carries Orion crew exploration vehicle with crew of 6 to International Space Station or 4 to Moon
- LH₂/LOX upper stage
 - Powered by a single engine derived from the Saturn J-2
- Single 5-segment RSRM first stage

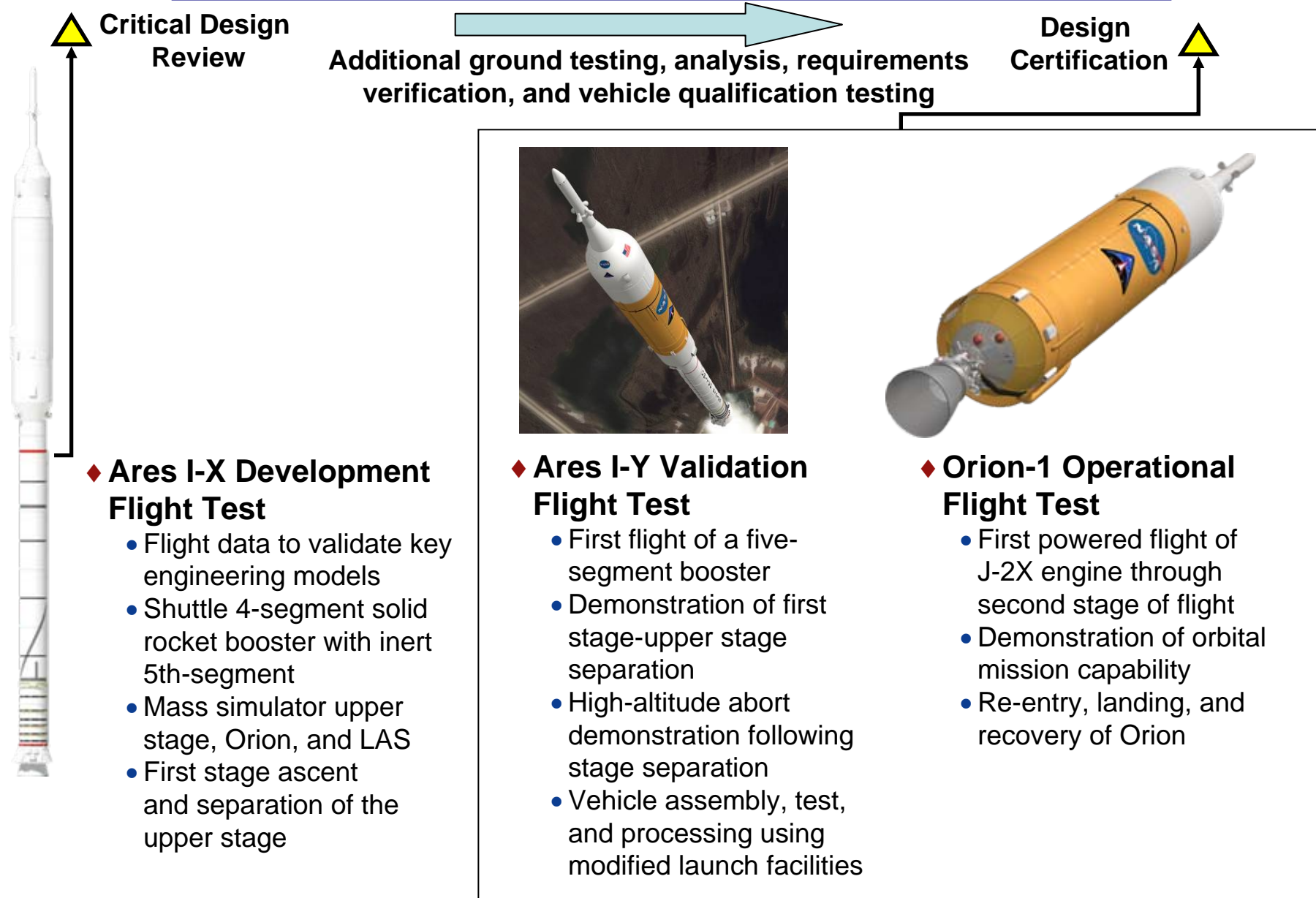
◆ Ares V Cargo Launch Vehicle

- Carries Altair lunar lander and performs trans-lunar injection burn to send Orion and Altair to Moon
- Twin 5.5-segment RSRM first stage
- Core stage derived from the external tank (ET) and Saturn V, powered by six RS-68 engines
- Ares I-derived avionics
- Earth departure stage (EDS)
 - Powered by a single J-2X upper stage engine – completes orbital burn and performs trans-lunar injection
 - Ares I-derived Main Propulsion System (MPS) and avionics





Flight Test Events Leading to Design Certification





First Stage Test and Evaluation



Jumbo Drop Test Vehicle (JDTV)



First Stage DDT-1



Solid Rocket Motor Test Firing

- ◆ **Drogue Parachute Drop Test (DDT-1) successfully completed**
 - First drop test of the new Ares I first stage booster reentry drogue parachute
 - Jumbo Drop Test Vehicle (JDTV) extraction from C-17 aircraft
 - Descended to test condition
 - Deployment and inflation of the drogue test parachute was successful
- ◆ **Ares I-X will provide flight testing for main parachutes**
- ◆ **Development test motor series**
 - Four development motor firings planned
 - DM-1 fabrication is underway
- ◆ **Qualification test motor series**
 - Three qualification motor firings planned



J-2X Engine Test and Evaluation



J-2X PPA-1A



Workhorse GG Test



*PPA-2
Concept*

♦ Early risk reduction testing

- Power Pack Assembly 1A (PPA-1A) testing with heritage J-2 turbomachinery and gas generator completed in May 2008
- Subscale injector testing complete
- Workhorse gas generator testing is underway

♦ J-2X Power Pack Assembly #2 (PPA-2)

- Planned for early 2010
- Expand on the test results from the PPA-1 series with flight-design components
- Evaluate turbomachinery, inlet ducts, gas generator, and other components

♦ Development and certification engines

- More than 200 engine hot-fire tests with 9 engines planned
- Sea-level and simulated altitude conditions



J-2X Engine Facility Readiness



A-1 Test Stand



A-2 Test Stand



A-3 Test Stand Site

◆ SSC A-1 Test Stand

- Provides sea-level test capability (no diffuser)
- Power-pack and engine testing (no nozzle extension)

◆ SSC A-2 Test Stand

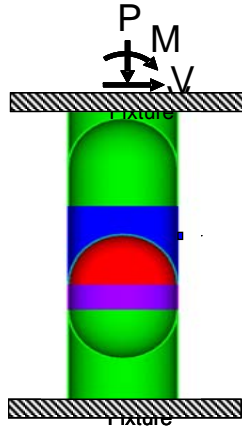
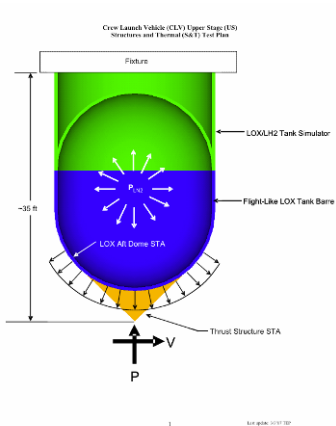
- Capable of sea-level testing or steady-state altitude simulation (no altitude start)
- Facility modifications to support J-2X

◆ SSC A-3 Test Stand

- New facility to provide altitude test capability for J-2X
- Tests the J-2X engine over the 500-sec duration burn at simulated altitudes over 100,000 feet
- Perform system start and shutdown without sea-level transient loads
- Development, certification, and acceptance testing



Upper Stage Structural and Thermal Test and Evaluation

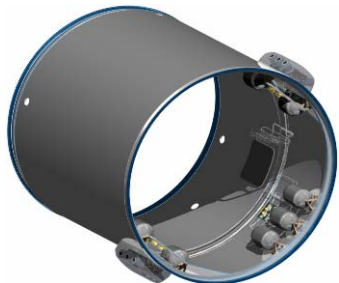
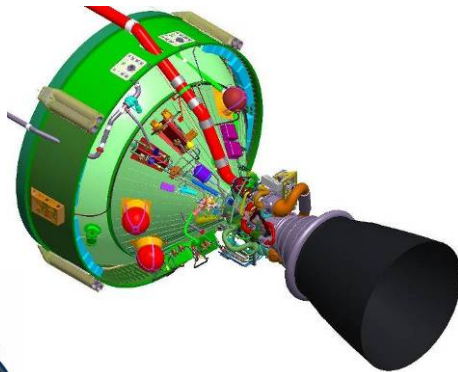


◆ Development test articles

- Common bulkhead
- LOX tank/aft dome/thrust structure
- Damage tolerance testing

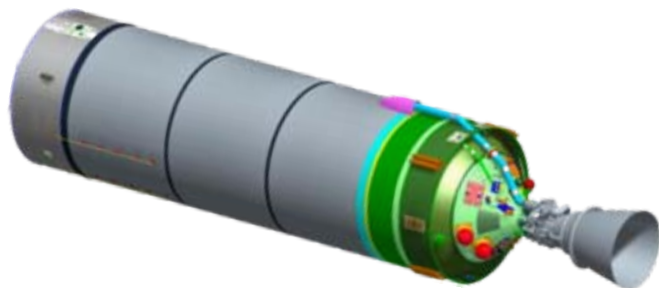
◆ Qualification Test Articles

- Instrument Unit
 - Structural qualification units for IU and avionics panels
 - Thermal qualification for IU avionics
- Interstage
 - Structural qualification
 - Life cycle testing
 - Thermal qualification
- Structural qualification test articles
 - LOX tank/aft dome/thrust structure
 - “Core” upper stage integrated stack with LH2 / LOX tanks, aft dome, and thrust structure





Main Propulsion Test Article (MPTA)



♦ Test purpose

- Test-bed for propellant management and stage operations of an Integrated Upper Stage (US and J-2X Engine)

♦ Specific test objectives

- Propellant management
- Thermal model validation
- Pressurization system performance
- Transient and main stage performance
- Terminal drain demonstration
- Cryogenic operation of MPS components
- Avionics demo
- TVC operations

♦ Approach

- Integration with J-2X development test Engine after engine sea-level testing
- Cold-flow test objectives complete prior to Ares I-Y
- Hot fire testing complete prior to Orion 1



Upper Stage Green Run Testing



◆ Test purpose

- Final acceptance of the integrated upper stage and upper stage engine configuration before eventual transport to launch site

◆ Objectives

- Hot fire test of the flight upper stages with the J-2X flight engine
- Possible verification testing for early stages leading to flight readiness

◆ Approach

- Potential cold-flow testing with Ares I-Y stage
 - Risk reduction for Ares I-Y tanking
 - Test stand activation
- First three stages beginning with Orion 1
 - Need for continued testing will be evaluated after Operational Capability is achieved





Upper Stage Facility Readiness



Hazardous Structural Test Facility



Cryo-Structural Test Facility



Advanced Engine Test Facility



B-2 Test Stand

◆ MSFC Hazardous Structural Strength Test Facility

- LOX tank/aft dome structural development and qualification testing

◆ MSFC Cryo-structural Test Facility

- Core structural qualification test article

◆ MSFC Advanced Engine Test Facility

- Main Propulsion Test Article

◆ SSC B-2 Test Facility

- Stage green run testing
- Plans for further modification to support Ares V core stage testing



Integrated Vehicle Ground Vibration Test (IVGVT)



◆ Test purpose

- Provide test-verified models for structural dynamics and flight control system

◆ Specific test objectives

- Obtain and verify mode shapes, frequencies, generalized mass, and damping characteristics which are used in the stability equations
- Obtain experimental non-linear characteristics of the vehicle
- Obtain amplitude and phase response data at flight control sensor locations

◆ Approach

- Full-scale test articles to simulate flight-like Ares I vehicle dynamic response
- Test at NASA-MSFC Dynamic Test Stand



IVGVT Dynamic Test Stand Readiness



*Dynamic
Test Stand*



*Workers cutting a section of
the platform prior to removal*



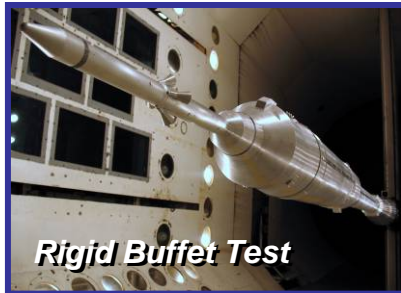
*A section of the platform
being removed*



*Lowering of the crosswalk to
facilitate platform removal*



Aerodynamic Testing



◆ Testing at the Preliminary Design Review (PDR) stage

- Multiple facilities and speed regimes (subsonic, transonic, and supersonic) to support aerodynamic characterization for ascent, stage separation, and booster re-entry
- 0.5-percent and 1.0-percent scale models
- Completed approximately 60 percent of total wind tunnel test program (approximately 6,000 hours)

◆ Additional testing prior to CDR

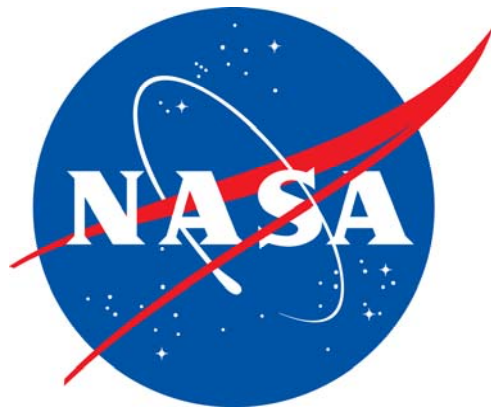
- Reynolds number scale effects
- Aerodynamic interference effects during stage separation
- Plume interactions from reaction control systems
- Higher fidelity configuration assessments



Summary



- ◆ **NASA is maturing test and evaluation plans leading to flight readiness of the Ares I crew launch vehicle**
- ◆ **Key development, qualification, and verification tests are planned**
 - Upper stage engine sea-level and altitude testing
 - First stage development and qualification motors
 - Upper stage structural and thermal development and qualification test articles
 - Main Propulsion Test Article (MPTA)
 - Upper stage green run testing
 - Integrated Vehicle Ground Vibration Testing (IVGVT)
 - Aerodynamic characterization testing
- ◆ **Test and evaluation supports initial validation flights (Ares I-Y and Orion 1) and design certification**



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